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Measuring farmer conservation behaviors: Challenges and best practices

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ABSTRACT

This article presents a guide for understanding the purposes and appropriate uses of different measures of conservation behavior. While applicable across natural resource management contexts, we primarily draw upon agricultural conservation research to illustrate our points. Farmers are often of interest to researchers, program managers, extension professionals, and non-governmental environmental organizations due to the significant impact of agricultural production practices on environmental resources. Practitioners are often interested in producer behaviors when they are planning or evaluating a project, developing or evaluating policy, or developing and testing theory. Within those bounds, we identify when it is most useful to assess an actual behavior (self-reported or observed) or behavioral intention (willingness or intent to pay/accept, support/participate in a policy or program, or engage in a conservation practice), and present examples of how they have been used in the past. We close with three recommendations for those conducting research related to agricultural producer behaviors: 1) research should be theoretically grounded, even when the purpose isn't to develop theory; 2) great care should be used when selecting behavior measures, dependent upon the purpose of the research, and 3) composite measures should be used when possible and appropriate.

1. Introduction

Agricultural practices can have significant impacts on environmental quality, and substantial effort has been dedicated to identifying what influences farmers' decisions and incorporating that knowledge into projects, programs, and policies. For example, fifty-five articles that quantitatively modeled conservation adoption were identified and synthesized by Prokopy et al. (2008) and Baumgart-Getz et al. (2012), and numerous articles have been published in subsequent years, providing evidence that this is an important area of research. Given this effort, it is important to consider how behavioral information is collected and measured for different purposes. Behavior measures, often collected through observation and self-reports, are commonly used for three general purposes: to inform planning/evaluation of project-level activities, to develop/evaluate policies intended to influence behaviors, and to develop/test theoretical constructs. Survey questionnaires – administered via mail, phone, web, or a trained interviewer – rely upon respondents to accurately self-report their behaviors and factors likely to have influenced those behaviors, rather than directly measure behavior through observation. Baumeister et al. (2007) critique over-reliance on self-reported behavior, stating, "people have not always done what they say they have done, will not always do what they say they will do, and often do not even know the real causes of the things they do" (p. 397). Observations, on the other hand, are unique in that they do not rely on self-reports and can result in more accurate measurement. However, they can be cost-prohibitive and may not provide information about independent variables relevant to behavioral decisions.

Recognizing these issues, along with needs and constraints associated with incorporating behavioral information into programs and policies, this paper provides an overview of how behavior can be measured using observation and questionnaires. Using examples from

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studies of farmers, we discuss common ways behavior is measured, and outline when each is best used for theory development, program/policy development, and project level planning/evaluation.

2. Types of behavioral measures

Behavioral research generally focuses on two categories of dependent variables: 1) behavior and 2) willingness or intent. These variables can be operationalized in a variety of ways: behavior can be observed by a researcher or self-reported by participants on questionnaires. Willingness or intent is usually measured through questionnaires. In social psychology, behavioral intentions refer to the proximate antecedent of behavior (Fishbein and Ajzen, 2010), though economists often conceptualize this direct antecedent as a clear preference for a particular choice (willingness-to-pay, discussed below).

Within these two categories of dependent behavioral variables, there are a number of approaches researchers can use for measurement depending upon the theoretical approach or purpose of the research. While some posit observed behavior is the ultimate goal of behavioral research (Baumeister et al., 2007), other forms of behavioral data can be useful for theory development, policymaking, or program development. Table 1 shows the types of behavioral dependent variables and their characteristics, including how they are typically assessed, their primary uses and applications, and example measures used in research. In the following sections, we present more detail about these categories of behavior measures and factors to be considered when selecting a behavior dependent variable.

2.1. Observed behavior

Actual behavior (e.g. not willingness or intent to take an action) is measured through direct observation or self-reports. Direct observation allows researchers to "find out how something factually works or occurs" by evaluating how people act versus what they say (Flick, 2009p. 222). Participant observation, when a researcher studies people's actions by observing and/or participating in those activities, is a hallmark of social science research and provides rich first-hand descriptions of activities (Kawulich, 2005). However, this type of research can be time consuming, costly, and not always possible, so alternative methods, including field observations and secondary data, are also used.

Field observations can occur in numerous ways, but windshield surveys and GIS are commonly used. Coffey et al. (1998), for example, describe conducting "windshield surveys" of study participants' farms, where they drove by and recorded crops that had been planted. Satellites offer an additional option for observing behavior: Hively et al. (2015) used a windshield survey and satellite imagery to assess cover crop adoption on farms over time, which was used to help evaluate educational program impacts. Overall, directly measuring behaviors has the potential for producing highly reliable information on actual behaviors. However, field studies can be costly and time consuming, and programmatic, remote sensing, and consumer data may not always be available or at the appropriate scale for analysis.

Another option for collecting measures of actual behavior is secondary data from program participation (e.g., farm conservation programs). Schaible et al. (2015), for example, evaluated field-level conservation practice and program participation data from a United States Department of Agriculture farmer survey and environmental data from the National Resources Inventory to investigate factors influencing environmental stewardship in U.S. agriculture.

2.2. Self-Reported behavior

Researchers often rely on self-reports to assess the degree to which social actors are engaged in actual conservation or ecological behaviors (Milfont, 2009). For example, study participants have been asked to report their behaviors related to nutrient management (Ulrich-Schad

Table 1
Behavioral dependent variable measures and their characteristics.

	Methods of Assessment	Uses/Applications	Expense/special considerations	Common Measures
Behavior				
Observational behavior	Programmatic/secondary data, researcher observation, remote sensing data	Highly reliable measures of actual behavior	High cost	Programmatic data, including program participation rates, recorded adoption of practices
		Geographic extent of behavior	Sometimes data unavailable	Remotely sensed or researcher observed practice adoption (rare in studies exploring decision making processes)
			Program data may underreport extent of behavioral adoption (only assesses program participation)Most commonly used behavioral measure, easy to collect	Reported adoption of practices/behaviors
Self-reported behavior	Questionnaires	Cost effective way to measure actual behavior among research population	Possibly misreports actual adoption	Reported program participation
			Difficult to measure intensity of behavioral adoption, rather than binary adopt/do not adopt	
Behavioral Intention				
Willingness to pay/ willingness to accept	Surveys (especially stated choice/ contingent valuation studies)	Useful for assessing impacts of program design and implementation (highly useful at policy and program levels)	Complex instrument design, often high cost compared to other survey methods	Contingent valuation
			High respondent burden, possibly leading to response bias	Stated choice
Willingness to participate	Surveys, programmatic/secondary data	Policy assessment, program development and evaluation	Social desirability bias	Self-reported willingness to participate in policy or program
Willingness to adopt	Surveys	Useful in prospective explorations of behavior, esp. program development	Social desirability bias	Self-reported willingness to adopt a behavior or practice

et al., 2017), cover crops (Dunn et al., 2016), and participation in government programs (Petrzelka et al., 2012). While observational data tend to be more reliable, self-reported data are often simpler, more efficient, and cost-effective for gathering behavioral information from large study populations. However, self-reports have drawbacks including participant misreporting and limitations associated with data collection methods, such as low response rates or incomplete or inaccurate sampling frames. Some studies have also revealed low correlations between self-reported and observed measures of conservation behavior (e.g., Corral-Verdugo, 1997).

Individuals may also misreport their behavior intentionally or unintentionally. This challenge is not unique to research soliciting self-reports from farmers, as studies of decision-making that utilize measures assessing hypothetical adoption of behaviors should acknowledge that people's predictions of how they will react in the future may not match their real actions (Baumeister et al., 2007). Another reason for biased reports from farmers may be the potentially controversial or sensitive nature of the behavior being examined in the study, which may lead farmers to misreport to deflect attention from their actions or influence the outcome of the analysis (Thomson and Tansey, 1982). Mech et al. (2000) suggest that intentional false reporting may explain interview results where farmers reported higher rates of cattle depredation from wolves than the U.S. Department of Wildlife Services personnel working in the Minnesota study area. A related problem is that a social desirability effect leads to a tendency for people to answer environmental questions in a manner which paints them in a positive light (Beckman, 2005; Paulhus, 1991). Milfont (2009), however, claims that social desirability is not as large a problem as it has often been considered. In studies asking about past behavior, participants may have difficulty accurately recalling their behavior leading to unintentional misreporting through recall bias (Dillman et al., 2014; Eisenhower et al., 1991). Question misinterpretation, potentially caused by overly complicated or confusing question wording, may also lead study participants to answer survey questions inaccurately. For this reason, careful questionnaire design and pre-testing are essential to increase measure accuracy (Dillman et al., 2014).

2.3. Willingness and behavioral intention

Willingness and behavioral intention are commonly measured when information on actual behavior is not needed. Behavioral intention is a necessary precursor to behavior, but not a perfect predictor of it (Fishbein and Ajzen, 2011). However, there can be a significant lag between intention and actual behavior; often the behavior never occurs without intervention. The theory of planned behavior and its successor, the reasoned action approach (Fishbein and Ajzen, 2011), explain this as the moderating effects of perceived behavioral control and intention. For example, an individual may form the intention to participate in a given policy or program but not be presented with the actual opportunity. Klöckner (2013) points to habit as an important element that can interfere in the actualization of behavioral intentions, especially for frequently-performed behaviors that can become deeply habitualized.

Many economics-based studies focus on willingness-to-pay for non-market goods or willingness-to-accept a given policy/program as dependent behavioral variables. These measures are congruent with the behavioral intention concept from the social psychology literature. Particularly in cases where the policies or target behaviors do not yet exist, there is no way to elicit direct behavior for pricing of non-market goods: these prices would be observed behavior. As pointed out above, revealed preferences for substitute goods or avoidance costs, or behavior in relation to simulated markets or policies, can be used in cases where no directly observable economic behavior exists (such as with many ecosystem services). In these cases, economists instead focus on the attributes of program or policy approaches, and elicit stated preferences from respondents using questionnaires.

Stated preference methods elicit an individual's preferences by asking the person to choose from hypothetical alternatives. One method of doing so is contingent valuation (CV), which presents a respondent with a series of yes/no decision for the provision of an environmental service at a particular price, and is intended to reveal willingness-to-pay for provisions of a non-market ecosystem service, such as environmental services (Carson, 2012; Hanemann, 1994). Contingent valuation applies to more situations than observed behavior approaches, including estimating non-use or existence values. There has been a continuing debate regarding whether CV generates meaningful results (Hausman, 2012), but there is growing consensus that carefully designed CV surveys can provide useful information (Carson, 2012; Carson et al., 2001; Hoyos, 2010).

Another method that overcomes some of the weaknesses in CV is the choice experiment (CE; Adamowicz et al., 1998). In CE studies, respondents are asked to make choices between varying bundles of attributes. Statistical methods are used to value marginal changes in attributes based on respondents' choices. For example, Ruto and Garrod (2009) used a CE to evaluate farmers' preferences for agri-environmental programs. They included program attributes such as minimum agreement length, whether the program would allow flexibility in conservation practices, and level of paperwork. Each questionnaire included different values for program attributes (such as low, medium, or high paperwork requirements) in two random bundles and then asked farmers whether they would participate in either program. The authors determined the impact of each program attribute on the level of program payment required for each level of that attribute. Choice experiments provide the opportunity to value marginal changes in attributes that may be difficult to observe using revealed preference approaches.

Behavioral intention and willingness must be used with great care and are best used for program/market development (e.g.Yeboah et al., 2015; Jiang and Ku, 2014). In developing an educational campaign, for example, answers to intention and willingness questions can help focus efforts on practices for which there appears to be a generally positive attitude. The campaign can focus on shifting respondents from intention to actual behavior by assessing barriers (physical, psychological and financial) preventing respondents from already adopting the desired behavior.

Intentions and preferences can also be used for program evaluation or projections about future resource conditions, but must do so with the understanding that intentions are not always translated into behavior (Fishbein and Ajzen, 2010). Stavins (1999) used revealed preferences for policy evaluation and forecasting when studying farmers' land use decisions. Using existing data, he estimated a model of land-use changes as a function of forestry and agricultural prices and land productivity, and created a simulation model to predict land uses as a function of a subsidy for conversion from agriculture to forestry. These simulations estimated the marginal costs (i.e., the cost of the subsidy) of carbon sequestration from additional area of forests. The major advantage of this approach is that simulations of marginal costs build directly upon revealed preference patterns of how landowners have actually responded to economic incentives they are continually presented with for alternative uses of their lands.

3. Recommendations for researchers

The high level of interest in conservation behaviors is evident in the extensive research measuring behaviors and willingness to engage in future action. Despite this interest, behavioral research can be challenging due to human behavior complexity, uncertainties about basic behavioral theories, and difficulties with instrument design. To guide researchers and practitioners in these areas, we offer three recommendations: 1) behavioral research should be theoretically grounded, even when the purpose is not to contribute to theory development; 2) great care should be given to selecting behavioral dependent variables, with measure selection driven by the research

purpose; and 3) researchers should consider composite behavior measures or triangulating self-reported and observational data to overcome potential measurement error, thereby improving the validity of the study.

Data collection methods influence the reliability and validity of self-reported data, making question design for questionnaires critical. To ensure the most reliable and valid measures, researchers should consider theoretical perspectives on behavior and direct antecedents of behavior. Not all behaviors are created (or conceptualized) equally: for example, the differences between exploring an intentional action requiring a high degree of pre-planning versus attempting to capture spontaneous behavioral responses influence appropriate measurement options. Is the behavior something that occurs at a discrete place and time or a single action/relatively rare occurrence (such as converting from traditional to no-till corn production); a repeated action occurring over a long period of time (such as ongoing fertilizer management); or a series of sequential actions with defined outcomes depending on decisions made during the process (such as decisions related to nutrient management, where formulation, placement, and timing are interdependent)?

There is a reasonable expectation of differences regarding how behavioral measures are designed based on the purpose of the research question. To be most effective, the end use of the information should drive the choice of behavioral measures. Examples of conservation behavior measures identified in both academic and practice-oriented publications demonstrate possible behaviors range from individual actions, such as the use of cover crops as part of farm management (Dunn et al., 2016), to more complex community or group-based actions, such as the participation in lengthy collaborative management projects (Koehler and Koontz, 2008). As shown in Table 2, we've broken down the general purposes of these measures into the following categories: to inform planning and evaluation of project-level activities, to develop and evaluate policies aimed at influencing behaviors, and to develop and test theories and theoretical constructs. A common challenge for evaluating the appropriateness of behavioral measures in the literature is the lack of clarity about where on this spectrum the purpose of the research falls. It may seem appropriate that the use of simple measures or those that are easiest to deploy, such as 'check all that apply' lists of dissimilar conservation behavior options, are more acceptable at the project scale than in the theory development arena. However, the same pitfalls exist in both circumstances as the need to minimize measurement error is equally important at the theoretical, policy, and project levels. Both researchers and practitioners need valid, reliable information to inform their decisions. Results can be biased when systematic measurement error, stemming from poorly conceived or operationalized items designed to capture behavior, occurs − especially in cases where the respondent feels pressure to provide a socially desirable response (Blattman et al., 2016).

Finally, researchers should consider developing composite measures of behavior and blending observational and self-reporting methodologies when actual behavior measures are needed. Aggregate measures (e.g. summated rating scales) increase confidence in measurement reliability and validity, and provide an avenue for enhancing explanatory power of models examining conservation behavior. Aggregate measures can result in losing unique characteristics of different types of behavior (Kaiser et al., 2005), though incorporating observational data can help reconcile this issue. Baumeister et al. (2007) suggest directly measuring behaviors along with any "…inner processes that mediate and produce those behaviors," (p. 401). Researchers could survey multiple actors (e.g., parent and adult child in one farming operation) to assess the degree to which self-reported behaviors correlate, or implement longitudinal panel studies. Researchers must also balance research and variable design with the practicalities of conducting research. While observational data are invaluable, they are often much more cost or effort-intensive than self-reports. Multi-mode or multi-implementation approaches to survey multiple populations also imposes non-trivial

Table 2
Examples of different dependent variable measures in theory development, policy, and project level applications.

Purpose of measurement	Behavioral Intention Measures			Behavioral Measures	
	Willingness to support policy/participate	Willingness to pay	Willingness to adopt	Observed behavior	Self-reported behavior (past/current)
Theory Development and Testing	Vanslembrouck et al., 2002: Used farmer willingness to participate in agri-environmental to assess microeconomic utility model and impact of demographic and farm characteristics on participation.	Pouta and Rekola 2001: Used WTP measure (conceptualized as behavioral intention) to assess impact of TPB* variables.	Cross 2015 used TPB/TRA, and Leopold's Land Ethic to predict attitudes toward participating in Farm Bill programs.	Wu et al., 2004 developed an economic model of conservation practice adoption using 4 years of crop choice and tillage data.	Weber and McCann 2015: Used USDA self-report data on N mgmt practice adoption to assess impact of various information and farm system factors.
Policy Development and Evaluation	Yeboah et al., 2015: Used stated willingness to participate in CREP[a], explored programmatic, socio-psychological, and demographic determinants of participation decisions.	Johnston and Duke 2007: Used WTP* measure to assess impacts of policy process attributes in agricultural land preservation programs.	Mukherjee 2010: Assessed impact of new nutrient-based fertilizer subsidy on farmer willingness to adopt nutrient BMPs*.	Schaible et al., 2015: Used federal conservation program participation data to compare participants and non-participants to identify differences in preferences.	Petrzelka et al., 2012: Used survey data to study the determinants of absentee landowner participation in USDA set-aside and cost share programs with the goal of increasing participation in such programs.
Project Level Planning and Evaluation	Birol and Cox 2007: Used choice experiment (willingness to participate) to assess program attributes that would maximize participation and benefits.		Lambert et al., 2014: Assessed stated willingness of cattle ranchers to adopt BMPs to protect water quality in a prospective watershed protection plan.	Hively et al., 2015: Used windshield survey and remote sensing to assess cover crop adoption and help evaluate impact of related education program.	Moon and Cockrin (2011): Used interview data with program participants to explore motivations and barriers to participation; Busse et al., 2015: Used pre- and post-survey data to assess the effectiveness of outreach on urban and agricultural residents' attitudes towards and usage of water quality conservation practices.

[a] BMP – Best Management Practice; CREP-Conservation Reserve Enhancement Program; TPB – Theory of Planned Behavior; TRA – Theory of Reasoned Action; WTP – Willingness to Pay.

costs on researchers. Longitudinal studies can be expensive and methodologically difficult to carry out. Researchers must carefully balance the costs and effort required for different variable formulations or data collection methods with the theoretical and methodological value of the data collected, with a reasonable expectation of what can be undertaken for a given study. Limiting the geographic or temporal scope of research is one potential way to implement high-quality/intensive data collection efforts for reasonable cost and effort.

While the focus of this paper is on quantitative behavior measures, some lessons also apply to qualitative research methods frequently used to understand conservation behavior (e.g., in-depth interviews, focus groups). Qualitative methods can also be used to test theory, develop policy, and plan projects, and are particularly well-suited for working with new or understudied target populations. Qualitative methods are also useful for pre-testing questionnaire design and question wording. Researchers should consider mixed methods approaches, using qualitative data to drive quantitative measure development or explain quantitative results, as part of the larger research approach.

4. Conclusion

In this paper, we argue that careful consideration of the dependent variable measure (behavior, either directly observed or self-reported, and antecedents of behavior, including behavioral intention and willingness conceptualizations) are critical for the success of social science research in general and research on farmer adoption of practices in particular. This is the case regardless of whether the purpose of the study is academic (theory development) or practical (program development and evaluation). To this end, we provided a basic overview of the theoretical and applied underpinnings of common behavior measures, and specific recommendations for undertaking this type of research. Most critically, researchers must ensure that they are measuring what they intend to measure (e.g. behavior vs. willingness), which begins with theoretical grounding of research constructs and careful crafting of methods and measures. We hope that this provides useful guidelines for behavioral research in natural resource contexts.

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